

# Dietary habits of rhesus monkeys (*Macaca mulatta* Zimmermann) in Indian forests<sup>1</sup>

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A year's study of rhesus monkeys in forest habitats in north India revealed that the diet is largely frugivorous, but also includes a variety of leaves, stems, flowers, buds, and insects. There was no evidence of feeding on animal matter other than insects. The diet varies considerably on a seasonal basis, due to changes in food availability. Regional differences in diet may be primarily a consequence of regional variation in available food plants.

Although the rhesus monkey has been studied in its natural habitat by a number of investigators in recent years, as yet no detailed information on dietary habits has been reported. The species occupies a wide range of habitats in present-day India (Southwick, Beg, & Siddiqi 1965; Neville 1968; Mukherjee 1969), but is by nature a forest adapted animal. I conducted a field study of two populations in 1965-66, one located in forest parcels at the Forest Research Institute in Dehra Dun, and the other in the nearby Asarori forest, located on the north slopes of the Siwalik Hills. Descriptions of these habitats and many facets of rhesus monkey behaviour have previously been published (Lindburg 1971). I present here unpublished data on the dietary habits of these two populations.

The monkeys at Asarori were observed for a 12 month period, beginning in June, 1965. Data for the FRI population were collected over a nine month period, beginning in August,

1965. Botanic samples of plants used as food were routinely collected and preserved for later identification by the FRI staff in Dehra Dun. Estimates of the importance of different items in the diet were based on numbers of individuals feeding on a particular source and the relative length of feeding periods.

## THE ASARORI POPULATION

The monkeys in the Siwalik forest occupied portions of the Asarori, Laldhang, and Mohamadpur blocks, as shown on Survey of India maps of the region. A portion of the range of these monkeys extended into privately owned forest near the village of Mahobiwalla. Records of the Dehra Dun Forest Division for the reserved part of the range (Nath 1963) indicate a predominance of relatively immature *Shorea robusta* Gaertn. in this region of the Siwaliks, but substantial areas are taken up by *raos* and by mixed inferior forest (Table 1). Those sections of the forest bordering along *raos* proved to be important feeding areas during the latter part of the dry season and throughout the monsoon months, whereas the

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winter range was located primarily within the mixed inferior forests of the region.

The rhesus monkeys at Asarori were predominantly vegetarian in their feeding habits. They utilize a wide range of trees, shrubs, climbers, grasses, and herbs. Table 2 presents a complete list of all plant foods consumed at Asarori, the portions preferred, and the months of the year in which they were utilized. While

TABLE 1

MAIN TYPES OF COVER IN THOSE PORTIONS OF THE ASARORI, LALDHANG, AND MOHAMADPUR BLOCKS USED BY THE SIWALIK STUDY POPULATION

Type	Per cent
<i>Shorea robusta</i> , 85 to 95 ft high	40.3
<i>Shorea robusta</i> , 75 to 85 ft high	29.9
<i>Shorea robusta</i> , 65 to 75 ft high	23.4
Mixed forest, no commercial value	1.6
Grassland, eroded stream beds	4.8
Total	100.0

a wider variety of leaves was exploited than of any other portions, estimates of quantities consumed indicated that wild fruits accounted for nearly 70 per cent of the total diet. The most heavily used fruits, in decreasing order of importance were: *Shorea robusta* Gaertn., *Syzygium cumini* (L.) Skeels., *Grewia elastica* Royle, *Phoebe lanceolata* Nees, *Ehretia laevis* Roxb., and *Carissa spinarum* A. DC.

These fruits varied greatly in their seasonal availability, except for a few days' overlap in the occurrence of *Grewia* and *Phoebe* after the monsoon, and the simultaneous appearance of *Shorea* and *Ehretia* during the dry season. No wild fruits were available during the greater

part of August. In the winter season, limited quantities of the fruits of *Carissa* and of *Cudrania javanensis* Trecul. were consumed, but at this season the diet became much more variable, consisting of a variety of leaves, grasses, and herbs (note the variation in number of different food plants consumed per month in Table 2).

We confirmed Roonwal's (1956) observation that rhesus monkeys voraciously consume wild mushrooms, mainly during the month of August. "Puffballs" of the genus *Scleroderma* were similarly sought from October into December. When feeding on the leaves of *Cudrania javanensis* Trecul., the monkeys showed a distinct preference for those which had been attacked by a fungus. Gupta (1962) notes that such leaves, called *mande-ki roti*, are often used as food by humans.

Included among the food plants of the monkeys' diet are some which are known to have toxic properties. For example, the seeds of *Abrus precatorius* Linn. were regularly eaten, apparently without adverse effects, even though they are reported to cause death in humans and animals (Gunn 1969), and are used in India for poisoning cattle and humans (Chakravarty 1969). The fruits of *Casearia graveolens* Dalz. and *C. tomentosa* Roxb. are used to poison fish (Gupta 1962), but as far as we could determine, the monkeys ate only the leaves of these two plants. A number of other items in the diet are used in folk medicine, and possibly are toxic if consumed in sufficient quantity.

Insects such as hoppers, ants, termites, and beetles were consumed in small quantities in all months of the year. The abundant population of peafowl and red jungle fowl at Asarori is indirect evidence that eggs are not a part of the monkeys' diet. To test this possibility, we placed hen's eggs in an area where we

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TABLE 2

FOOD PLANTS UTILIZED BY RHESUS MONKEYS IN THE SIWALIK FOREST AT ASARORI

Species	J	J	A	S	O	N	D	J	F	M	A	M	Part consumed
<b>GRASS</b>													
<i>Arundinella nepalensis</i> Trin.										X		X	Stem
<i>Capillipedium hugelii</i> Hack.						X	X		X				Seed
<i>Digitaria setigera</i> Roth.*	X	X	X	X	X	X	X	X	X				Seed
<i>Oplismenus compositus</i> Lam.				X								X	Seed
<b>HERB</b>													
<i>Aerides multiflorum</i> Roxb.						X	X	X	X	X			Whole plant
<i>Ageratum conyzoides</i> Linn.*						X	X	X					Stem, flower
<i>Argemone mexicana</i> Linn.										X			Flower
<i>Cassia tora</i> Linn.						X							Seed
<i>Colocasia esculenta</i> (L.) Schott.			X										Stem, leaf
<i>Commelina obliqua</i> Ham.							X						Leaf
<i>Datura alba</i> Nees.								X					Pith of stem, leaf
<i>Dioscorea belophylla</i> Voigt.*						X	X	X	X				Leaf, seed
<i>Drymaria cordata</i> Willd.								X					Whole plant
<i>Galium triflorum</i> Michoc.*								X					Whole plant
<i>Globba racemosa</i> Smith.	X	X	X	X	X								Stem
<i>Moghania bracteata</i> Roxb.									X				Seed
<i>Oxalis corniculata</i> Linn.								X	X				Whole plant
<i>Parilla ocymoides</i> Linn.						X							Seed
<i>Rumusatia vivipara</i> Scholt.			X	X									Stem
<i>Stellaria media</i> (L.) Cyrill.*							X		X	X			Whole plant
<i>Zinziber roseum</i> Roxb.							X	X					Flower
<b>CLIMBER</b>													
<i>Abrus precatorius</i> Linn.*	X	X	X		X	X	X	X					Leaf, seed
<i>Aspidoterys wallichii</i> Hook. f.			X										Leaf
<i>Atylosia crassa</i> Prain.					X	X	X	X					Leaf
<i>Bauhinia vahlii</i> W. and A.						X							Stem (new growth)
<i>Melotheria heterophylla</i> Cogn.*			X										Stem, leaf
<i>Milletia auriculata</i> Baker						X		X	X	X	X	X	Pith of stem, root
<i>Porana paniculata</i> Roxb.					X	X		X	X				Leaf
<i>Rhaphidophora glauca</i> Schott.						X							Leaf
<i>Scindapsus officinalis</i> Schott.								X					Fruit, bark
<i>Smilax indica</i> Vitm.						X	X	X	X				Pith of stem, leaf, fruit
<i>Spatholobus roxburghii</i> Benth.					X	X	X	X	X	X	X	X	Pith of stem, leaf
<i>Ventilago calyculata</i> Tulasne.*						X	X						Pith of stem, leaf
<i>Zehneria umbellata</i> Thev.									X				Stem
<b>SHRUB</b>													
<i>Aerua scandens</i> Wall.													Leaf
<i>Agave wrightii</i> D. and P.	X								X				Leaf

TABLE 2 (continued)

Species	J	J	A	S	O	N	D	J	F	M	A	M	Part consumed
<i>Antidesma diandrum</i> Roth.						X	X	X	X				Leaf
<i>Ardisia solanacea</i> Roxb.						X	X	X					Stem, leaf, fruit
<i>Carissa spinarum</i> A. DC.*						X	X	X	X	X			Pith of twigs, fruit
<i>Cudrania javanensis</i> Trecul.*			X	X	X	X	X	X	X				Leaf, fruit
<i>Desmodium latifolium</i> DC.									X				Leaf
<i>Ficus clavata</i> Wall.							X						Leaf
<i>Gongronema nepalensis</i> Dcne.							X						Leaf
<i>Gymnema tingens</i> W. and A.							X						Fruit
<i>Indigofera pulchella</i> Roxb.										X			Leaf
<i>Jasminum multiflorum</i> (Burm. f.) Andr.*						X	X	X	X	X	X	X	Stem, leaf, flower
<i>Lantana camara</i> Linn.*			X				X						Fruit
<i>Murraya exotica</i> Linn.				X					X	X			Leaf, fruit
<i>Murraya koenigii</i> Spreng.*				X					X	X			Leaf, fruit
<i>Opuntia dillenii</i> Haw.	X							X		X	X		Leaf
<i>Pueraria tuberosa</i> DC.		X	X										Flower
<i>Randia dumetorum</i> Lamk.*							X	X	X		X		Leaf, bark
<i>Rubus lasiocarpus</i> Sm.*	X					X	X	X	X	X	X	X	Leaf
<i>Solanum hispidum</i> Pers.*						X							Pith of stem, fruit
<i>Zizyphus jujuba</i> Lamk.*							X						Fruit
<b>TREE</b>													
<i>Acacia catechu</i> Willd.										X			Seed
<i>Aegle marmelos</i> Correa.							X	X					Fruit
<i>Albizia lebbek</i> Benth.*							X						Leaf, seed
<i>Bauhinia malabarica</i> Roxb.				X	X								Leaf, seed
<i>Bauhinia variegata</i> Linn.											X		Flower
<i>Bombax malabaricum</i> DC.*								X		X			Leaf, seed, flower
<i>Buchanania latifolia</i> Roxb.		X											Fruit
<i>Butea monosperma</i> Lamk.							X	X		X			Pith of twig, flower
<i>Careya arborea</i> Roxb.	X												Pith of twig, fruit
<i>Casearia graveolens</i> Dalz.												X	Leaf
<i>Casearia tomentosa</i> Roxb.												X	Leaf
<i>Cordia myxa</i> Linn.	X												Fruit
<i>Dalbergia sissoo</i> Roxb.*										X			Leaf, seed, bud
<i>Ehretia laevis</i> Roxb.									X	X	X		Fruit
<i>Eugenia operculata</i> Roxb.				X			X						Fruit
<i>Ficus cunia</i> Ham.												X	Fruit
<i>Ficus religiosa</i> Linn.*								X					Leaf
<i>Ficus roxburghii</i> Wall.							X	X	X	X	X		Pith of twig, fruit
<i>Firmiana colorata</i> R. Br.							X						Pith of leaf stem
<i>Grewia elastica</i> Royle			X	X	X								Fruit
<i>Kydia calycina</i> Roxb.				X									Leaf
<i>Lagerstroemia parviflora</i> Roxb.						X							Fruit

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TABLE 2 (continued)

Species	J	J	A	S	O	N	D	J	F	M	A	M	Part consumed
<i>Mallotus philippinensis</i> Muell.*					X	X							Stem, fruit
<i>Markhamia platycalyx</i> Sprague.										X			Leaf, flower
<i>Milusa velutina</i> H. f. and Th.								X		X	X		Leaf, flower
<i>Ougeinia dalbergioides</i> Benth.				X						X			Leaf, flower
<i>Phoebe lanceolata</i> Nees.				X	X	X							Fruit
<i>Pyrus pashia</i> Ham.*				X	X	X	X						Fruit
<i>Semecarpus anacardium</i> Linn.			X				X						Pith of twig
<i>Shorea robusta</i> Gaertn.*	X	X	X		X	X	X	X	X	X	X	X	Pith of twig, leaf, flower, fruit, bud, shoots
<i>Sterculia pallens</i> Wall.						X	X						Pith of leaf stem
<i>Sterculia villosa</i> Roxb.		X	X										Pith of leaf stem
<i>Syzygium cumini</i> (L.) Skeels	X	X			X	X	X	X					Fruit
<i>Terminalia alata</i> Meyne ex Roth.					X	X	X	X					Leaf, fruit
<i>Terminalia belerica</i> Roxb.			X						X				Resin, fruit
FUNGI													
<i>Russula</i> sp.*		X	X	X									Whole plant
<i>Scleroderma</i> sp.					X	X	X						Whole plant
Total species per month	6	10	13	15	12	25	41	29	28	24	11	11	

\* Also utilized by monkeys at the Forest Research Institute.

expected the monkeys to pass later in the day. Several walked over the eggs without noticing them; others sniffed, handled, and eventually bit into the shells, then appeared startled when the yolk ran out. These behaviours clearly suggest investigation of an unfamiliar item.

The feeding activities of rhesus monkeys result in considerable damage to certain kinds of vegetation. Feeding on the tender, young leaves of *sal* seedlings, for example, results in their being completely stripped of leaves or even uprooted. The large leaf stems of species such as *Sterculia pallens* Wall. and *Kydia calycina* Roxb. were frequently broken off and peeled in order to get at the pith. Altogether, we noted peeling of stems or terminal twigs of 15 different species, including *sal*.

COMPARISON WITH THE FRI POPULATION

The monkeys at the Forest Research Institute utilized 24 of the same plant species as the monkeys at Asarori. Like other monkey groups living in close proximity to human habitation, the FRI groups were frequently fed by man, and commonly raided nearby fruit orchards, gardens, and fields. Excluding the latter from the tabulation, we found that the FRI monkeys exploited at least 45 foods not consumed by the Asarori monkeys (Table 3). Much of the difference in diets for the two populations is simply a matter of availability. Although the vegetation at FRI contains a number of naturally occurring species, it also contains many introduced species not found at Asarori.

TABLE 3

PARTIAL LIST OF FOOD PLANTS UTILIZED BY RHESUS MONKEYS AT THE  
FOREST RESEARCH INSTITUTE, DEHRA DUN\*

Species	Part consumed
GRASS	
<i>Saccharum spontaneum</i> Linn.	Stem, shoot
HERB	
<i>Launaea aspleniifolia</i> DC.	Leaf, flower
<i>Polygonum serrulatum</i> Lagasc.	Flower
<i>Pueraria phaseoloides</i> Benth.	Stem
<i>Rubia cordifolia</i> Linn.	Pith of stem, leaf, fruit
<i>Vicia sativa</i> Linn.	Seed
CLIMBER	
<i>Paederia foetida</i> Linn.	Leaf
<i>Passiflora suberosa</i> Linn.	Fruit
SHRUB	
<i>Camellia theifera</i> Griff.	Stamen
<i>Caryota mitis</i> Lour.	Pith of stem
<i>Clerodendron infortunatum</i> Gaertn.	Flower, fruit, new leaf
<i>Desmodium gangeticum</i> (L.) DC.	Leaf
<i>Diospyros cordifolia</i> Roxb.	Fruit
<i>Flemingia congesta</i> Roxb.	Seed
<i>Hamiltonia suaveolens</i> Roxb.	Leaf
<i>Hibiscus rosa-sinensis</i> Linn.	Pith of stem, flower
<i>Karogana chamlagu</i> Lam.	Flower
<i>Rauwolfia serpentina</i> Benth.	Flower
<i>Rhamnus virgata</i> Roxb.	Leaf, fruit
<i>Wistaria sinensis</i> Sweet.	Flower
TREE	
<i>Alseodaphne keenanii</i> Nees.	Fruit
<i>Aleurites fordii</i> Hemsl.	Leaf, flower, shoot
<i>Anthocephalus cadamba</i> Miq.	Fruit
<i>Bauhinia purpurea</i> Linn.	Flower
<i>Bischofia javanica</i> Bl.	Fruit
<i>Broussonetia papyrifera</i> Vent.	Leaf, flower, fruit, shoot, pith of stem
<i>Cedrella toona</i> Roxb.	Fruit
<i>Chrysophyllum oliviforme</i> Linn.	Fruit
<i>Cinnamomum camphora</i> Linn.	Fruit
<i>Eriobotrya japonica</i> Lindl.	Fruit
<i>Ficus benjamiana</i> Linn.	Fruit

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TABLE 3 (continued)

Species	Part consumed
<i>Ficus glomerata</i> Roxb.	Fruit
<i>Ficus palmata</i> Forsk.	Leaf, fruit
<i>Hovenia dulcis</i> Thunb.	Fruit
<i>Leucanea glauca</i> Benth.	Leaf, seed
<i>Litchi chinensis</i> Sonner.	Fruit
<i>Litsaea polyantha</i> Juss.	Pith of stem
<i>Mangifera indica</i> Linn.	Fruit, flower, seed
<i>Mimusops hexandra</i> Roxb.	Fruit
<i>Morus alba</i> Linn.	Bud, new leaf, fruit
<i>Premna latifolia</i> Roxb.	Leaf
<i>Prunus persica</i> Benth.	Fruit
<i>Psidium guyava</i> Linn.	Fruit
<i>Quercus serrata</i> Thunb.	Seed
<i>Santalum album</i> Linn.	Fruit

\* Additional food plants for the FRI population are listed in Table 2.

The principal value of the FRI data on diet is in demonstrating the range of items which may be used as food, and in further illustrating the capacity of the species to adjust its feeding habits to locally available resources, an attribute which has enabled it to survive and flourish as its original habitat disappeared.

One of the more interesting observations at FRI was the feeding on stamens of the tea plant, *Camellia theifera* Griff. In late October we began to notice a yellow substance on the faces of the monkeys, and later determined it to be pollen from the flowers of the tea plant. This pattern of feeding continued throughout November and over the first half of December.

## FEEDING BEHAVIOUR IN OTHER AREAS

Very little information is presently available on dietary habits of rhesus monkeys from other regions. In Table 4 we list food plants noted in travels of forested regions in other parts of

north India. The combined total of unique food plants from the three tables equals 150. Given the geographical distribution of rhesus monkeys, it is reasonable to expect that diets will vary considerably from region to region.

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TABLE 4

LIST OF PLANT FOODS CONSUMED BY RHESUS MONKEYS IN OTHER FOREST AREAS IN INDIA

Species	Where collected	Part consumed
GRASS		
<i>Arundinella nepalensis</i> Trin.	Corbett Park	Stem
<i>Dendrocalamus strictus</i> Nees.	South Kheri	Leaf
<i>Saccharum spontaneum</i> Linn.	South Kheri	Shoot
HERB		
<i>Galium aparine</i> Linn.	Mussoorie	Whole plant
SHRUB		
<i>Berberis lycium</i> Raf.	Mussoorie	Bud, new leaf
<i>Carissa spinarum</i> A. DC.	West Timli	Fruit
<i>Ervatamia coronaria</i> Stapf.	South Kheri	Leaf
<i>Punica granatum</i> Linn.	Tatura, Chandigarh	Leaf
<i>Reinwardtia trigyna</i> Planch.	Mussoorie	Flower
<i>Strobilanthes glutinosus</i> Nees.	Mussoorie	Flower
TREE		
<i>Azadirachta indica</i> A. Juss.	Corbett Park	Leaf
<i>Bauhinia malabarica</i> Roxb.	South Kheri	Seed, seed pod
<i>Butea monosperma</i> Lamk.	Mohand	Flower
<i>Careya arborea</i> Roxb.	Corbett Park	Pith of stem
<i>Dalbergia sissoo</i> Roxb.	Corbett Park, S. Kheri	Seed, bud, new leaf
<i>Ehretia laevis</i> Roxb.	Mohand	Fruit, flower
<i>Ficus nemoralis</i> Wall.	Mussoorie	Leaf stem
<i>Ficus religiosa</i> Linn.	Corbett Park	Leaf
<i>Madhuka latifolia</i> Gmel.	South Kheri	Bark
<i>Pinus roxburghii</i> Sargent	Chandigarh	Seed
<i>Quercus incana</i> Roxb.	Mussoorie	New leaf
<i>Rhododendron arboreum</i> Sm.	Mussoorie	Leaf, flower
<i>Shorea robusta</i> Gaertn.	West Timli	Flower

REFERENCES

- CHAKRAVARTHY, R. S. (1969): More about *Abrus precatorius*. *Science* 166:44.
- GUNN, C. R. (1969): *Abrus precatorius*: Pretty but Poisonous. *Science* 164:245-246.
- GUPTA, B. L. (1962): Forest Flora of the Chakrata, Dehra Dun and Saharanpur Forest Divisions, Uttar Pradesh. Third Ed., Government of India Press, Calcutta.
- LINDBURG, D. G. (1971): The Rhesus Monkey in north India: An Ecological and Behavioural Study. In Primate Behaviour: Developments in Field and Laboratory Research (L. A. Rosenblum, Ed.), Vol. 2, pp. 1-106. Academic Press, New York.
- MUKHERJEE, R. P. (1969): A field study on the behaviour of two roadside groups of Rhesus Macaque [*Macaca mulatta* (Zimmermann)] in nor-



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- thern Uttar Pradesh. *J. Bombay nat. Hist. Soc.* 66: 49:110-123.  
(1):47-56.
- NATH, K. (1963): Working Plan for the Dehra Dun Forest Division, Uttar Pradesh, 1959-60 to 1968-69. Deputy Conservator of Forests, Naini Tal.
- NEVILLE, M. K. (1968): Ecology and Activity of Himalayan Foothill Rhesus Monkeys. *Ecology*
- ROONWAL, M. L. (1956): Macaque Monkey Eating Mushrooms. *J. Bombay nat. Hist. Soc.* 54:171.
- SOUTHWICK, C. H., BEG, M. A. & SIDDIQI, M. R. (1965): Rhesus Monkeys in north India. *In Primate Behaviour: Field Studies of Monkeys and Apes* (I. DeVore, Ed.), pp. 111-159. Holt, New York.